instruction manual

No. 113

FOR

"MA" NOBATRONS

Sorensen & Company, inc.

375 Fairfield Avenue

Stamford, Conn.

No. 113

INSTRUCTION MANUAL

SORENSEN "MA" NOBATRONS

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SORENSEN & CO., INC., 375 Fairfield Avenue, Stamford, Conn.

SB14-1666 A

I GENERAL INFORMATION

Introduction

Before you begin to use your new Sorensen instrument we suggest that you read this Instruction Manual very carefully. The information contained herein is designed to help you obtain the maximum in performance and many years of dependable service from your instrument.

Shipping Damage

The instrument should be inspected and tested immediately upon arrival. In the event the unit fails to operate properly or is damaged in any way the carrier should be notified at once. When the claim agent has inspected the shipment and prepared a report of damage a copy of this report should be sent to us. At that time we will advise you concerning the repair or replacement of the instrument.

Service Information

All questions concerning the operation or malfunctioning of this instrument should be directed to the Service Department, Sorensen & Company, Inc., 375 Fairfield Avenue, Stamford, Conn.

IMPORTANT

BE SURE TO INCLUDE THE **MODEL** AND **SERIAL** NUMBER IN ALL CORRESPONDENCE CONCERNING THIS INSTRUMENT. WITHOUT THIS INFORMATION WE MAY NOT BE ABLE TO GIVE YOU PROMPT AND ACCURATE SERVICE.

IN THE EVENT OF DIFFICULTY

Should you receive a defective or damaged instrument or require service on an instrument within or outside of warranty, please write us. Be sure to include as much information as possible concerning the symptoms of difficulty, the application, input line voltage, etc. The more information you give us the faster we can handle your request.

In each case we will decide whether the instrument requiring service will be (a) returned to the factory, (b) shipped to a service station, or (c) serviced at your plant by one of our field engineers or representatives.

Shipments

If the instrument should be returned to the factory we will send you shipping instructions in the form of a Returned Material Tag. DO NOT SHIP A UNIT TO THE FACTORY WITHOUT THIS TAG.

Warranty

This instrument is warranted by Sorensen & Company, Inc., to be free from defects in material and workmanship. Our obligation to the original purchaser under the warranty is limited to servicing the instrument and replacing defective parts when the instrument is returned to the factory with transportation charges prepaid. No other warranties may be implied.

The period of warranty is one year after the date of delivery of the instrument to the original purchaser.

Defects caused by improper operating conditions, accidents, misuse or negligence and the alteration or removal of the nameplate will void the warranty.

II "MA" Nobatron Specifications

The MA Nobatron is a low voltage, high current, tubeless, regulated DC supply manufactured by Sorensen & Co., Inc.

MA Nobatrons are either self contained or designed for relay rack or cabinet mounting. Complete details on each model are given in the following specifications.

Following are the basic general specifications for MA Nobatrons. More details on electrical specifications will be found in Table I and on mechanical specifications (including controls) in Table II.

INPUT VOLTAGE

105 to 125 volts AC single phase (except MA28-50 which requires a three phase input of 190 to 230 or 210 to 250 volts).

Operation at lower or higher input voltages is possible with restrictions on the output voltage range and current rating. In general, operation at low input voltage is restricted at high output voltage and heavy load currents by the regulating range of the circuit. Conversely, operation at high input voltage is restricted at low output voltage and light load by the regulating range of the circuit. In addition, operation at high input voltage increases core loss of the transformers which must be compensated for by lower copper losses and hence lower output current.

Regulation is not guaranteed outside the 105 to 125 volt input range. Operation should not be attempted at higher than 135 volts input (270 on the MA28-50) to prevent exceeding the breakdown voltage rating of the various components.

INPUT FREQUENCY

60 cycles.

Operation over the range of 45 to 65 cycles is possible with restrictions on the input or output voltage range and output current ratings. In general, lower frequency operation with high input, low output and light load is restricted by the regulating range of the circuit. Operation under the same conditions of input and output voltage and with full load current results in increased transformer core losses which must be compensated for by lower copper losses. Conversely, operation at a higher frequency with low input, high output and heavy load is undesirable.

In addition to the above, it should be noted that the ripple voltage increases at lower frequencies. Also, the specified regulation accuracy applies only to 60 cycle operation and regulation against frequency change is not guaranteed.

OUTPUT VOLTAGE ADJUSTMENT

See Table I.

REGULATION ACCURACY

$\pm 1\%$ for load and line changes combined from no load to full load over rated input voltage range. Note that the regulation accuracy applies to line and load combined so that if line and load are changed separately, the total regulation accuracy may be as good as $\pm .5\%$. The changes against both line and load are as a rule uniform, so that if the output voltage is set with 115 volts input at half load, the maximum change for line would be .25% up at 125 volts

half load and .25% down at 105 volts half load.

Due to the nature of the load compensating circuit the change with load may be in either direction (up or down .25% to full load and down or up .25% to no load).

RIPPLE

1% RMS maximum at 60 cycles. 2.5% maximum at 45 cycles.

Ripple specifications will be met at full load over the rated input voltage range and over rated output voltage adjustment at normal room temperatures. Ripple decreases as the load current decreases. Also, the percentage of ripple increases as the output voltage is decreased. Below 15°C. (59°F.) the ripple will increase and may be above 1%. At low temperatures the high initial ripple will be decreased as the unit warms up.

RECOVERY TIME

See Table I.
Recovery time is defined as the time constant of the unit or the time for the output to effect a 63% recovery from the maximum deviated value. The time required for the output to return to within 1% of the initial value is longer than this and is difficult to measure.

Load transients will cause the output voltage to change. The amount of change depends on the magnitude and rate of rise of the transient, and the amount of capacity across the output of the Nobatron. The Nobatron output voltage will begin to recover in .04 seconds or less. The magnitude of the voltage change may be reduced by adding additional capacitors across the output but this may increase the recovery time beyond the specified interval.

Line transients will also be attenuated by the filter capacitors as well as by the inductances of the magnetic amplifier and the filter choke.

AMBIENT TEMPERATURE RANGE AND DRIFT

+15°C. (61°F.) to +35°C. (95°F.)

Output voltage will not change more than .5% for changes of ambient from 15°C. to 35° C.

While operation at lower and higher temperatures, is possible, regulation is not guaranteed outside these temperature limits. In addition, the ripple specification is not guaranteed below 15°C.

If operation above 35°C. is attempted, the life of various components will be reduced. In some cases, however, operation at reduced loads is possible at higher ambients. This of course is at the discretion and responsibility of the user.

After allowing 30 minutes for warm-up, drift at fixed ambient should not be more than .5%.

In the event the Nobatron is to be exposed to unusual temperature conditions, we suggest consultation with the factory for information concerning precautionary measures. At such times full details on the application should be forwarded to us.

TABLE I
ELECTRICAL SPECIFICATIONS

MODEL	MA6-5A	MA6-40	MA-12-20	MA-28-50		
INPUT VOLTAGE RANGE	105-125	105-125	105-125	190-230 210-250 (1)		
FREQUENCY	60 cy.	60 cy.	60 cy.	60 cy.		
PHASE	1	1	1	3		
OUTPUT VOLTAGE ADJUSTMENT RANGE	5.40-6.60	4.50-7.70	11.0-15.0 or (2) 12.0-16.0	23.0-32.0		
OUTPUT CURRENT	5A	40A	20A	50A		
REGULATION ACCURACY (Line and Load Combined)	±.2%	±1%	±1%	±1%		
RIPPLE	1% RMS	1% RMS	1% RMS	3% RMS		
RECOVERY TIME	.15 sec.	.20 sec.	.30 sec.	.50 sec.		
AMBIENT TEMPERATURE RANGE	15°C. (61°F.) to 35°C. (95°F.)					
INPUT CURRENT	2A	12A	12A	15A		
SENSING OR REFERENCE ELEMENT	Silicon Diode	Lamp Bulb	Lamp Bulb	Silicon Diode		
CONTROL MAGNETIC AMPLIFIER	No	Yes	Yes	Yes		

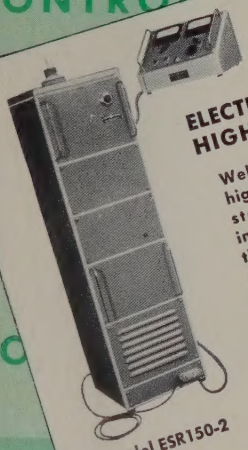
(1) 210 or 230 nominal input by top change.

(2) Two ranges by adjustment of R3 behind front panel. Set at 12.0-16.0 on shipment.

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

NEW

ELECTROSTATIC GENERATOR HIGH VOLTAGE SUPPLIES



Well-regulated, easily-controlled high voltage supplies providing substantial power for a variety of industrial and laboratory applications. These highly efficient electrostatic units offer a safe, simple and compact high voltage source for many operations, such as non-destructive insulation testing, electrostatic precipitation and particle acceleration.

Model ESR150-2

ELECTRICAL CHARACTERISTICS:

	ESR150-2	EPR150-2
Input	220 volt, 3 phase 50 or 60 cycles	220 volt, 3 phase 50 or 60 cycles
Output voltage	50-150 kilovolts	5-160 kilovolts
Output current	2.4 ma. maximum	2.0 ma. maximum
Regulation	±2% against load ±4% against line	±0.2% against load; better than ±0.1% against line
Stability	———	±0.02% per minute with a maximum of 1% during warm-up

NEW

WIDE RANGE FREQUENCY CHANGER

Latest, most versatile addition to the Sorensen line of regulated electronic frequency changers, the Model FCR250 converts your 50 or 60 cycle line to regulated output at any desired frequency between 320 and 1000 cps. This portable, practical unit can solve a wide variety of your laboratory, test or production requirements.

Model FCR250

ELECTRICAL CHARACTERISTICS:

Input	105-125 VAC, 1 phase, 50-65 cycles
Output voltage	115 VAC, adjustable 105-125V
Output Frequency	320-1000 cps in two ranges
Voltage regulation	±1%
Frequency Regulation	±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)
Load range	0-250 VA

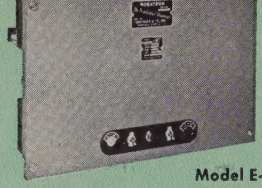
Sorensen

1956

CONDENSED STANDARD SPECIFICATIONS

other units

SORENSEN & COMPANY, INC., • STAMFORD • CONNECTICUT



Model E-6-15A

NOBATRONS (Reg. U.S. Pat. Off.)

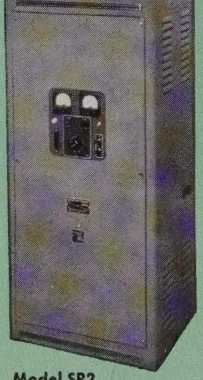
(low-voltage, high-current, regulated DC sources).

Provide stability comparable to batteries and eliminate recharging interruptions, fume and acid hazards, installation difficulties.

Models available (numbers indicate voltage & current) E-6-15A, E-6-40A, E-6-100A, E-12-5, E-12-15, E-12-50A, E-28-5, E-28-10, E-28-30, E-28-70, E-28-150, E-48-15, E-125-10, E-200-5.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles. 190-260 VAC, 1ϕ, for E-28-70, 120/208, 3ϕ, 4-wire wye for E-28-150.
Reg. accuracy	$\pm$0.2% against line (105-125 volts or 200-240 volts). $\pm$0.2% against load (1/10 to full).
Ripple	1% max. at 60 cycles.
Output voltage adjustment range	6 volt units. 5.4 to 7.7 volts in two ranges. E-12-50A, 9.0 to 17.6 volts in two ranges. E-200-5, $\pm$50%. all others +10%, —20%
Recovery time	0.2 seconds on all models but E-28-70 (0.25 sec.) and E-28-150 (0.3 sec.)



Model SR2

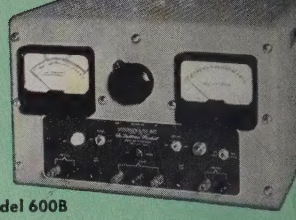
NOBATRON-RANGERS

(wide-range-variable regulated DC sources).

These versatile and popular instruments have electrical characteristics similar to the standard Nobatrons, except that output voltage is continuously adjustable.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles for SR30 and SR100. 190-260 VAC, 1ϕ, 50-60 cycles for the SR2.		
Reg. accuracy	$\pm$0.25% at any voltage setting		
Ripple	1% RMS max.		
Output: Model	SR100	SR30	SR2
VDC	5-135	5-30	100-300
Amps	1-10	3-30	1-10



Model 600B

B-NOBATRONS

(high-voltage, low-current, regulated DC s

Designed to meet the broadest techni economical requirements. The internal ance figures given are from measuren accordance with IRE specifications for m ment of power supply internal impedan

ELECTRICAL CHARACTERISTICS

Model	325BB	560BB	500BB	600B
Output voltage (VDC)	0-325	0-500	0-500	0-600
Output current (Ma)	0-125	0-200	0-300	0-500
Reg. accuracy	$\pm$0.5%	$\pm$0.5%	$\pm$0.5%	$\pm$0.2
Ripple (MV-RMS)	5 max.	5 max.	5 max.	3 max
Bias supply (VDC at 0-5 Ma)	0-150	0-150	0-150	0-150
Internal impedance (max.)	2.0 ohms	2.0 ohms	2.0 ohms	2.0 oh
AC input range (50-60 ~, 1ϕ)	105-125	105-125	105-125	105-12
AC voltage (C.T., unreg.)	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 15 am
Max. bias circuit impedance	25000 ohms	25000 ohms	25000 ohms	50000 ohms

Model FL5015

FILTER SECTIONS FOR NOBATRONS

The ripple voltage of all Nobatrons is 1% of the nominal output voltage setting, under worst conditions. This is adequate for most applications. If, however, less ripple is required, Filter Sections are available for use with units rated up to 50 amperes, which will reduce the ripple to 0.1%.

Model DE-28-10

400-CYCLE INPUT NOBATRONS

These instruments are not normal production items but are available on an extended delivery schedule.

ELECTRICAL CHARACTERISTICS

Output voltage and load range	Model DE-6-40 — 6 VDC at 4 to 40 amperes. Model DE-12-10 — 12 VDC at 1 to 10 amperes. Model DE-28-10 — 28 VDC at 1 to 10 amperes.
Input voltage	105-125 VAC, 1ϕ, 360-440 cycles.
Reg. accuracy	$\pm$0.25%.
Ripple	1% RMS maximum.
Recovery time	0.2 seconds.

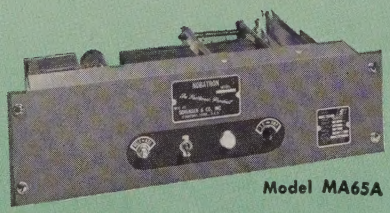
Model

T-NOBATRON

A variable voltage, low cost supply es designed for transistor circuit work. E line voltage regulation and transient re for line and load pulses.

ELECTRICAL CHARACTERISTICS:

Input	95-130 VAC, 60 cps
Output Voltage	0-50 volts DC in three 0-10, 0-25, 0-50 volts
Output Current	0-1.5 amperes DC
Regulation for line changes	$\pm$1% for 105-125 V $\pm$2% for wider input
Internal resistance	1 ohm on 10 V range, 2 ohms on 25 V range 4 ohms on 50 V range
Ripple	50 MV maximum



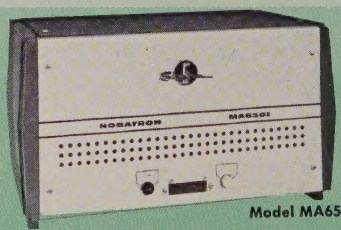
Model MA65A

TUBELESS REGULATED DC SOURCES

Designed for heavy-duty industrial applications, these instruments utilize magnetic amplifier principles and offer the utmost in reliability.

ELECTRICAL CHARACTERISTICS

Model	MA65A	MA640	MA2850
Input (VAC, 60~)	105-125, 1ϕ	105-125, 1ϕ	190-230, or 210-250, 3ϕ, 4-wire, wye.
Output (VDC)	5.4-6.6, adj.	4.3-7.7 adj.	23-32 adj.
Load range	0-5 amp.	0-40 amp.	0-50 amp.
Ripple	1% max.	1% max.	3% max.
Reg. accuracy	$\pm$0.2% against line or load	$\pm$ 1.0% for any combination of line and load.	
Recovery time	0.15 sec.	0.20 sec.	0.5 sec.



Model MA6501

PRECISION REGULATED TUBELESS DC SOURCE

A transistorized precision regulated DC source utilizing magnetic amplifier principles. This highly-stable, temperature-compensated unit is Sorensen's new design for use with the Beckman Model DU Spectrophotometer.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1ϕ, 60 cycle.
Output	#1 — 6 VDC adjustable internally $\pm$5%, 5 amperes load. #2 — 6 VDC, 100 milliamperes load. #3 — 2 VDC, 40-60 milliamperes
Reg. accuracy	$\pm$.01%.
Ripple	15 mv RMS max.on #1 and #2 5 mv RMS max. on #3
Stability	Typical stability after a 30 minute warm-up is .01% for an eight hour period.

Model MR3215

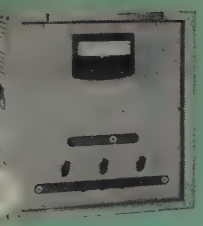
MAGNETIC RA

(tubeless wide-range variable regulated DC

A rugged, tubeless DC source requiri gible maintenance, the MR3215 is versatile unit providing continuously able output voltage.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1ϕ, 50-6
Output	5 to 32 VDC at 1.5 to 1 amperes, continuous adjustable.
Reg. accuracy	$\pm$0.5% against line. $\pm$0.5% against load
Ripple	1% RMS at 32 volts.
Recovery time	0.2 sec.



AC VOLTAGE REFERENCE SOURCES

These instruments provide highly stable AC voltage for many laboratory uses such as the direct calibration of voltmeters and oscilloscopes.

Model VRS-AC750

ELECTRICAL CHARACTERISTICS

	Model VRS-AC 10	Model VRS-AC 750
Input voltage	105-125 VAC, 1ϕ	
nput frequency	50-60 cycles; also to 400 cycles with minor loss of accuracy	60 cycles ±.5
Output voltage	10 mv to 10 v in 3 ranges	1-799 v in 1 v steps
Calibration accuracy	±0.1%	
Reg. accuracy	±0.25% with line; ±0.25% with load of .5 megohm or higher	overall accuracy * ±0.25%
Distortion (generated by instrument)	negligible	1% maximum

*Much greater accuracy possible through correction curves.

Model 1001

PRECISION AC REGULATORS *(electronic).*

Giving ultra-precise, ±0.01% regulation, these instruments are rugged and serviceable, as proved by hundreds of applications in the field. Models available with capacities of 1000VA and 2500VA.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50 and 60 cycles.
Output	115 VAC, 1ϕ, adj. 110-120.
Reg. accuracy	±0.01% against line, ±0.01% against load.
Distortion	3% maximum.
P.F. range	Unity to 0.7 lagging.
Load range	0 to full load.

Model 100

AC REGULATORS *(electronic).*

Utilizing the original Sorensen circuit and incorporating the *Safety Diode*, these regulators are noted for accuracy, economy of operation, easy maintenance. Models available with capacities from 150VA to 15KVA, single phase.

Models available (Numbers denote VA capacities) 150S, 250S, 500S, 1000S (-2S also), 2000S, 3000S (-2S also), 5000S (-2S also), 10000S (-2S also), 15000S (-2S also).

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50 or 60 cycles ±10%. 190-260 VAC in "-2S" models.
Output	115 VAC adj. 110-120; 230 VAC with "-2S" models.
Reg. accuracy	±0.1% against line, ±0.1% against load.
P.F. range	Unity to 0.7 lagging.
Distortion	Varies to 3% max. under worst conditions.
Load range	0 to full load.

Sorensen

THE WORLD'S AUTHORITY ON REGULATED POWER

Whatever your power control requirements, for industry, military applications or research, Sorensen can furnish a unit which meets your specifications *exactly*. A wide variety of instruments available in a broad range of capacities. Sorensen offers unusual experience in the engineering and production of special equipment for unique regulation problems.

Model D2500SAN

400-CYCLE AC REGULATORS

These instruments are available in models [illegible]50SAN, D500SAN, D1200SAN, D2500SAN [illegible]mbers 250, etc. denote VA capacities)

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ; 400 cycles ±10%.
Output	115 VAC, 1ϕ, adj. 110-120.
Reg. accuracy	±0.25% against line, ±0.25% against load
Distortion	5% maximum.
P.F. range	Unity to 0.7 lagging.

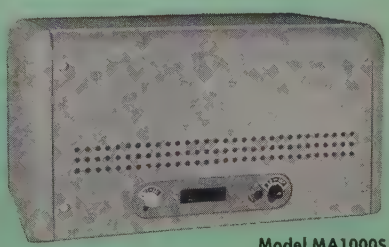
Model MVR500

MVR's (magnetic voltage regulators).

These magnetic voltage regulators are tubeless, give utmost reliability with good regulation. Very compact, they are ideally suited for incorporation as components. Available in capacities of 15, 30, 60, 120, 250, 500 and 1000 VA. MVR's with 6.3, 12.5 and 230 volt outputs are also planned.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 60 cycles.
Output	115 VAC nominal, 1ϕ.
Reg. accuracy	±0.5% against line.



Model MA1000S

TUBELESS AC REGULATOR

For unattended installations requiring extremely dependable automatic line regulation, the tubeless MA1000S offers stable long-life performance with an absolute minimum of maintenance.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50 or 60 cycles.
Output	115 VAC, adj. 110-120 v.
Reg. accuracy	±0.5% against line. ±0.5% against load.
P.F. range	Unity to 0.7 lagging.
Distortion	3% max. at 60 cycles.

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

FREQUENCY CONTROL

Sorensen electronic frequency changers convert 50 or 60 cycle line to 400 cycles regulated or 60 cycles regulated. These instruments have found manifold uses in laboratories, production lines and inspection sections.

1000VA FREQUENCY CHANGERS

Model FC 1000 (45-65 cps out.)
Model FCD 1000 (360-440 cps out.)

ELECTRICAL CHARACTERISTICS

Input	208 or 230 VAC ±10% 1ø, 50 or 60 cycles
Output voltage	115 VAC, adj. 105-125V
Voltage regulation	±1%
Output frequency	(FCD 1000) 360-440 cps (FC 1000) 45-65 cps
Regulation accuracy	±1% (±0.01% with auxiliary frequency standard fixed at 50,60 or 400 cps.)
Load range	0-1000 VA

Model FCD1000

SPECIAL EQUIPMENT

A few examples of Sorensen's wide range of specially-engineered equipment:

AIRBORNE ELECTRONIC FREQUENCY CHANGERS AND INVERTERS

Sorensen has designed and built a wide variety of frequency changers and inverters for incorporation in military aircraft. These instruments meet a great many different specifications and are not considered standard instruments. Each customer requirement is quoted on individually. For the most part, the changers convert variable (320-1000~) input power to precision (±0.05%) output frequency. Most models are also voltage regulated (±1%) with minimum distortion (5-10%).

Sorensen airborne inverters are built to convert 28 VDC input to 400-cycle, 3-phase output, with output frequency accurate to 0.05% over wide ambients.

Sorensen's wide experience with commercial and military frequency changers may well supply the answer to your precision frequency problems. Your inquiries are earnestly solicited.

COMPUTER POWER SUPPLIES

A major extension of Sorensen's know-how in the field of regulated power has been to the design of computer power supplies. Broad experience has been accumulated in the design and production of special power sources for electronic data-processing equipment. Let Sorensen apply this experience to your computer power supply problems.

COAST-TO-COAST

The authorized Sorensen representatives listed below are at your service. Do not hesitate to call on the one nearest you for advice on regulated power requirements.

ARIZONA — Tucson
Gerald B. Miller Co.
P.O. Box 11246
Phone Tucson 4-6293

CALIFORNIA — Hollywood 28
Gerald B. Miller Co.
1550 N. Highland Ave.
Phone Hollywood 2-1195

CALIFORNIA — San Diego 6
Gerald B. Miller Co.
1263 Rosecrans Blvd.
Phone Academy 2-1121

CALIFORNIA — San Francisco
Gerald B. Miller Co.
1334 Old County Rd., Belmont
Phone Lytell 3-3438

COLORADO — Denver 3
Hytronic Measurement Associates
446 Broadway
Phone Sherman 4-2241

CONNECTICUT — Bridgeport
Yewell Associates
1101 East Main Street
Phone Forest 6-3456

D.C. — Washington 9
Horman Associates, Inc.*
2017 S. Street, N.W.
Phone Decatur 2-5705

FLORIDA — Fort Myers
Arthur H. Lynch & Associates
P.O. Box 466
Phone Edison 4-4431

GEORGIA — Atlanta
Floyd Fausett & Son
777 Pinehurst Terrace, S.W.
Phone Raymond 3104

ILLINOIS — Chicago 39
Loren F. Green & Associates
5218 W. Diversey Avenue
Phone Palisade 5-6824

MARYLAND — Baltimore
Horman Associates, Inc.
635 St. Johns Road
Phone Hopkins 7-2290

MASSACHUSETTS — Boston
Yewell Associates *
751 Main Street, Waltham
Phone Twinbrook 3-7420

MICHIGAN — Detroit
S. Sterling Company*
15310 W. McNichols Road
Phone Broadway 3-2900

MISSOURI — Kansas City 30
Harris-Hanson Co.
7916 Paseo Ave.
Phone Hiland 6744

MISSOURI — St. Louis 17
Harris-Hanson Co.
2814 South Brentwood Blvd.
Phone Mission 7-4350

NEW JERSEY (Northern)
RMC Associates
114 East Main Street, Bogota
Phone Diamond 2-5343

NEW JERSEY (Southern)
I. E. Robinson Co.
702 Mattison Ave., Asbury Park
Phone Dunkirk 9-2404

NEW MEXICO — Albuquerque
Gerald B. Miller Co.
327 Wyoming, S.E.
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379 West 1st Street
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I. E. Robinson Co.
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Phone Regent 7-5541

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**Complete service facilities maintained for rapid local servicing of all Sorensen equipment.*

WRITE FOR LITERATURE Send for complete information, including specifications, performance data and quotations. Product data sheets are issued on all new units as they become available. Inquiries regarding special applications and specifications are invited. Address Sales Engineering Department, Sorensen & Company, Inc., 375 Fairfield Avenue, Stamford, Conn., or your local representative. In Europe, please contact directly Sorensen-Ardag, Eichstrasse 29, Zurich 3, Switzerland.

Sorensen

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TABLE II
MISCELLANEOUS SPECIFICATIONS

MODEL	MA 6-5A	MA 6-40	MA 12-20	MA 28-50		
TYPE CONSTRUCTION	Rack Mounting	Bench Model	Bench Model	Floor Model		
DIMENSIONS Rack	19" Wide 5¼" High 11" Deep	19" Wide 12¼" High 16" Deep	19" Wide 12¼" High 16" Deep			
Cabinet or Bench	21¾" Wide 7" High 11½" Deep	17¾" Wide 12¼" High 16" Deep	17¾" Wide 12¼" High 16" Deep	17" Wide 28¾" High 15¾" Deep		
WEIGHT	30 lbs.	110 lbs.	110 lbs.	210 lbs.		
INPUT TERMINALS	Terminal Board Lower Left	Line Cord (Rear)	Line Cord (Rear)	Terminal Boards Right Rear		
OUTPUT TERMINALS		Terminal Post (Right Rear)	Terminal Post (Right Rear)			
ON-OFF SWITCH	DPST	DPST	DPST	TPST		
OVERCURRENT PROTECTION	Input Fuse	Input Fuse	Input Fuse	Input Fuse		
METERS	Not Available	Optional	Optional	Standard		
PILOT LIGHT	Yes	Yes	Yes	No		
FAN COOLING	No	No	No	Yes		
VOLTAGE ADJUSTMENT	Screw Driver	Knob	Knob	Knob		

III INSTALLATION and OPERATION

Smaller units are made for standard 19" relay rack or cabinet mounting. Medium units are bench models with removable side and rear panels. These models may be rack mounted by the addition of special brackets. Large units are floor models on casters on which front and rear doors are provided. These units are not designed for rack mounting.

Bench models have side handles which must be removed for rack mounting.

Mounting

To mount rack type units in rack or cabinet, it is necessary to remove the front panels to make the mounting slots accessible. Mounting hardware is provided.

Bench models are mounted in racks or a cabinet by means of a special bracket attached to the unit if ordered specially. Handles must be removed from the side panels before mounting the unit in a rack.

Terminals

On rack mounted units input and output connections are made at terminal boards located behind the removable front panel through grommet holes in the side lips of the chassis. See Table II for the location of these terminal boards and for the type of terminals available on other units. A ground terminal is available on all units.

The wire size used in connecting a unit should be at least as large as that required to carry the input and output currents listed on the nameplate and Table II in accordance with applicable wiring codes covering the installation. It is recommended that even larger wire sizes be used on the output circuit in order to reduce the voltage drops between the terminals and load to a minimum.

Controls

An on-off switch is provided in all units. Even with the switch off, voltages still exist in the unit up to the switch terminals.

CAUTION: DO NOT TOUCH THE NOBATRON CIRCUITRY UNTIL THE INPUT POWER HAS BEEN DISCONNECTED EXTERNALLY BY A LINE SWITCH OR THE REMOVAL OF THE INPUT LINE PLUG FROM THE POWER OUTLET.

Output voltage is adjusted by means of a potentiometer (either screwdriver adjust or with knob.) Clockwise rotation increases the output voltage. A fine adjust potentiometer is provided in some units.

For safety reasons the user should provide a solid connection between the ground terminal post on the Nobatron and the electrical system ground. (Where a three wire input cable is provided all that is necessary is to connect the third wire to the system ground.)

Grounds

As no high voltages exist in the control circuit, units are shipped with the output floating. A ground terminal is provided, however, and either output terminal may be grounded.

Forced Air Cooling

Large three phase units are provided with fan cooling for the selenium rectifier. A thermal switch is provided on the rectifier to reduce the output voltage and limit the current in case of failure of the fan.

Nameplates

Sorensen strongly suggests that the nameplate be retained if the instrument is incorporated into other equipment. This will eliminate later difficulties if service or parts are required.

IV PRINCIPLE OF OPERATION

The operation of the unit can best be understood by referring to the schematic diagram furnished with each unit.

All components used together with their function, are listed below. (Note that any given model may not use all the components listed.)

R1 Resistance in series with the sensing or reference element forming non-linear voltage divider.

R2	Non-linear resistor or resistors used as sensing or reference element. This may be a semi-conductor or a tungsten filament.
R3	Output voltage adjustment used to center adjustment range.
R4	Output voltage adjustment potentiometer.
R5	Output voltage fine adjustment potentiometer in series or shunt with R4 (not usually used).
R6	Output voltage fine adjustment limiting resistor to protect and limit range of R5, if used in shunt with R4.
R7&R8	Sensing voltage divider resistors.
R9	Resistance in series with control coil on power amplifier for impedance matching.
R10	Bleeder resistor to provide minimum load on power amplifier and discharge condensers C1 and C2.
R11	Line compensating adjustment to control current in compensating windings of amplifier and compensating rectifier S3.
R12	Load compensating adjustment to control current in compensating winding of amplifier.
R13	Resistance in series with control coil on control amplifier for impedance matching.
R14	Resistance in series with bias winding on power amplifier to adjust bias.
R15	Resistance in series with pilot light.
R16	Ammeter shunt.
R17	Fixed resistor Q1 anti-hunt circuit.
R18	Resistor in base of Q1.
R19	Series resistor used with R11 and S3 bridge rectifier.
R20	Adjustable resistor Q1 anti-hunt circuit.
R21	Fixed resistance in series with R14.
C1	Input filter capacitors. Usually consists of several capacitors in parallel.
C2	Output filter capacitors.
C3	Stabilizing capacitor for power amplifier.
C4	Stabilizing capacitor for control amplifier.
Q1	High gain transistor.
S1	Power rectifier — may also act as rectifier in self-saturating circuit.
S2	Self-saturating rectifier in control amplifier circuit.
S3	Compensating rectifier.
S4	Self-saturating rectifiers, if separate from S1.
L1	DC choke.
T1	Power self-saturating magnetic amplifier reactor.
T2	Input transformer.
T3	Control self-saturating magnetic amplifier reactor.
SW1	Input switch.
SW2	Rectifier thermal switch.
F1	Input fuse.
PL1	Pilot light.
A	Ammeter.
V	Voltmeter.
M	Fan motor.

The MA Nobatron consists of a power self-saturating magnetic amplifier followed by a filter circuit and a tubeless control circuit using non-linear resistance as a reference element (or elements) and except in smaller units a control self-saturating magnetic amplifier.

The power circuit consists of a transformer T2, the self-saturating reactor T1 and associated rectifiers S1 and S2. In the center tap and the three phase circuits S1 acts as the rectifier required for self-saturation of the reactor as well as providing the DC output. In single phase bridge circuits, however, only two arms of the bridge rectifier (S2) act as self-saturating rectifiers, the other arms (S1) being used to assist in providing a DC output only. A third circuit is the AC doubler in which the magnetic amplifier with rectifier S2 is in the primary circuit of transformer T2 and provides AC output which is then transformed to the proper voltage and rectified by S1.

A detailed explanation of the theory of the magnetic amplifier is beyond the scope of this Manual. In simple terms, however, the AC coils on the reactor may be considered to act as "gates" which open at some time during the half cycle in which the rectifier S1 allows conduction. Until the gate opens, no current flows. After the gate opens current flows and is restricted only by the impedance of the load circuit. Thus the average current and hence the voltage is controlled by the fraction of the half cycle period that the gate is open. For example, if the input voltage is reduced, the current flow during the con-

ducting period will be reduced. Therefore, the gate must be opened earlier to maintain the same output voltage.

Opening of the gate is controlled by the current in the DC windings of the reactor T1. The self-saturating reactor differs from the older type reactors in that, with no control current, a large output current and voltage will result. Adding control ampere turns with the same polarity as the power ampere turns, as determined by the rectifier S1 or S4, will increase the output, and conversely, reducing the control ampere turns will decrease the output.

On most units the control current is supplied by a magnetic amplifier which only supplies current in one direction and requires the addition of a bias winding on the power reactor. The bias ampere turns reduce the output so that with no current in the control coil, it is less than the minimum voltage of the unit. Bias current may be a fixed current in series, or in shunt, with the sensing bridge, or may be a bias varying with the input voltage supplied through rectifier S3. In this case the bias windings also act as a compensating winding automatically changing the control ampere turns as the input changes, and reducing the ampere turns change required from the control circuit. Load compensating windings using a voltage drop across the filter choke, or a shunt, may also be used.

The control magnetic amplifier differs from the power magnetic amplifier only in that a better grade of iron is used giving higher gain. With this type of iron, essentially full output is obtained at zero ampere turns, so that no bias is necessary. Compensating windings may be used, however, which may require a fixed bias to balance out their average effect.

The sensing or reference element is some type of non-linear resistance; either a semi-conductor device such as a silicon diode operated in the reverse direction (high resistance or low conduction) or the tungsten filament of a lamp bulb. These non-linear devices have the property that as the voltage increases the resistance decreases and therefore the current increases faster than the voltage. If this change is great enough the non-linear element becomes a voltage reference holding a relatively constant voltage over a wide range of current. This reference element, R1, is placed in series with a linear resistor R2 across the output of the unit. A slight change in output voltage causes a larger change in current. This change in current causes the voltage drop through R2 to change more than if R1 was also a linear resistance. The voltage across R1 thus changes less than if it were linear. Another voltage divider, R7, R8, both linear, is also placed across the output. The voltage drop across R8, which varies in proportion to the output voltage change, is compared with the voltage drop across R2, which varies only slightly, and the difference is used to supply the control current to control reactor T3 (or T1 if T3 is not used).

In some cases the diagonally opposite arm of the bridge R7 is also non-linear. This is only done if the voltage drop is the same across all arms of the bridge and R7 is called R2 and R8 is called R1.

In order to improve the operating characteristics of the MA 6-5A, a high gain transistor circuit has been added to the instrument after serial # MA 42. THIS improves the regulation accuracy to ± .2%.

Voltage adjustment is made by the adjustable resistor R3 and the potentiometer R4 which may be in series with the entire sensing network, R1, R2, R7, R8, or may be included as part of the bridge between R7 and R8. Moving the slider of R3 or R4 in the plus direction decreases the output voltage.

In *units with no control reactor T3*, the voltage across R8 (which includes the voltage to the slider of R3 or R4 if this is between R7 and R8) is less than the voltage across R2. If the output voltage decreases due to more load or lower input voltage, the voltage across R8 decreases more than the voltage across R2, increasing the control current, thus opening the gate earlier and bringing the output up to its original value, less the amount of change determined by the gain of circuit to make this change.

In *units with a control reactor T3*, the voltage across R8 is more than the voltage across R2. If the output voltage decreases, the control current decreases which increases the output current of the control stage which therefore opens the gate earlier and so on as explained in the preceding paragraph.

IV MAINTENANCE and REPAIR

During normal life, this instrument requires no maintenance other than the care afforded similar equipment. Since the life of rectifier stacks can be considerably reduced by restricting the air flow over the plates, it is suggested that excessive dust, etc., be removed periodically. At such time care should be exercised to prevent damage to the plates by cleaning tools or excessively strong air blasts.

Spare Parts

All components used in these Nobatrons are of a good commercial grade and can be expected to give a reasonably long period of trouble-free service. As the age of the instrument increases, however, some components are likely to deteriorate; we therefore suggest that the customer contact our Service Department for a list of the parts that should be kept on hand.

In the event it becomes necessary to replace any part we strongly suggest that the replacement parts be of the same value as the original. Substitute parts should not be used unless we advise that the substitute part will not impair the performance of the instrument.

REPAIR

CAUTION

DANGEROUS VOLTAGES EXIST IN THIS INSTRUMENT. PLEASE OBSERVE APPROPRIATE PRECAUTIONS.

Typical circuit voltages and currents including direction of current are indicated on the schematic drawing supplied with each unit. All voltage measurements should be taken with a 1000 ohms per volt meter. All current readings should be taken with as low a resistance meter as possible.

SYMPTOM A — NO OUTPUT VOLTAGE

POSSIBLE CAUSE	Check:
AN OPEN IN THE POWER CIRCUIT	Test for an open circuit in one of the following components: on-off-switch, fuse, primary and secondary ot transformer T2, AC windings of reactor T1, rectifier S1, Choke L1.

SYMPTOM B — HIGH OR LOW OUTPUT VOLTAGE

This is probably due to failure of the sensing element or failure of the control reactor circuit. The first thing to check is the voltage across sensing element R2.
If the voltage across R2 is normal, then make the following checks:

POSSIBLE CAUSE:	Check:
CONTROL REACTOR GIVING LOW OR HIGH VOLTAGE	If the output is low, determine if the voltage is being applied to the circuit. Check current in the output of the reactor. Low output is due to no current or low current which may be caused by open rectifier S2, or open coils on T3. High output is caused by high current which may be caused by an open DC winding or an open circuit between the DC winding and the sensing bridge.

SYMPTOM C — HIGH RIPPLE

This is due to the failure of one or more of the electrolytic capacitors. Check the ripple voltage across C1. If this is normal or lower, failure is in the output bank (C2). If this is high, failure is in the input bank (C1).

SYMPTOM D — HUNTING OR OSCILLATION OF OUTPUT

This is due to the failure of the anti-hunt circuits utilizing capacitors C3 and C4 feeding back to coils on T1 and T3.
Check capacitors and windings on T1 and T3.

FILTER CAPACITORS

In the event one or more input filter capacitors (C1) fail, they should be replaced at once or else the load on the Nobatron should be reduced in proportion to the amount of capacity removed. If this precaution is not observed premature failure of the remaining input capacitors may result.

IN THE EVENT OF SERIOUS DIFFICULTY OR DAMAGE TO THE NOBATRON WE SUGGEST THAT CONSIDERATION BE GIVEN TO RETURNING IT TO THE FACTORY FOR REPAIR.

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